

Coral Cay Conservation

Marine Protected Area Assessment Report

Napantao MPA



Napantao
San Francisco, Southern Leyte, the Philippines

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Executive Summary

Coral Cay Conservation conducted an assessment of the reef fish, invertebrates, substrate and anthropogenic impacts in and around the Napantao MPA, in April 2013.

A modified Reef Check protocol was used to survey 6 transects, each containing four 20m replicates. Three transects were placed inside and three outside the MPA all at a depth of 12m.

Overall, fish abundance was not significantly higher inside the MPA compared to outside. Grouper species were however more abundant inside the MPA than outside.

Average size of Groupers recorded was higher inside the MPA than outside the MPA.

Total invertebrate abundance was not significantly different between inside and outside the MPA.

Drupella sp. were observed in significantly higher abundance inside the MPA than outside.

Percentage hard coral cover was significantly higher inside the MPA, though hard coral was the most abundant substrate both inside and outside the MPA, with rock also common inside and sand common outside.

Commercially important species, such as Groupers, Sweetlips, Giant Clams, Triton's Trumpet and species of Sea Cucumber, were observed in low abundances or were absent wholly from the entire area that was assessed.

Damaging impacts such as household trash, discarded fishing gear and anchor damage were observed in very low frequency or not observed at all. Furthermore coral disease and predation was low both inside and outside the MPA.

The greater abundance and size of Groupers inside the MPA may indicate that the MPA is achieving its intended purpose of increasing fish stocks of important commercial species.

The lack of other overfished species may indicate that fishing pressure is still high around the MPA.

The enforcement of the Napantao MPA is currently effective and there are good signs that it is achieving some of its conservation goals. Continued protection through community involvement is necessary to increase these trends.

Acknowledgements

Coral Cay Conservation would like to express our gratitude to the Provincial Government of Southern Leyte (PGSL). Our work would not be possible without the support of the Provincial Environmental and Natural Resource Management Office (PENRMO) and other members of the PGSL. We would also like to thank the Barangay Council of Napantao and the Municipality of San Francisco for facilitating the MPA assessment. In particular we would like to acknowledge the cooperation and continued support of Sir Danilo Calaycay, Barangay Captain of Napantao and Servando Tio Jr., San Francisco SB Secretary. Finally, we would like to thank our trained volunteers and staff who collected the data during this MPA assessment.

List of Acronyms and Abbreviations

CCC	: Coral Cay Conservation
CoTs	: Crown of Thorns Seastars (<i>Acanthaster planci</i>)
GPS	: Global Positioning System
IEC	: Information, Education, Communication
IUCN	: International Union for the Conservation of Nature
LGU	: Local Government Unit
MPA	: Marine Protected Area
MPA MEAT	: MPA Management Effectiveness Assessment Tool
MWU	: Mann-Whitney U test
NIA	: Nutrient Indicator Algae
NIPAS	: National Integrated Protected Area System
PRRCFI	: Philippines Reef and Rainforest Conservation Foundation Inc.
RKC	: Recently Killed Coral
SE	: Standard Error

Coral Cay Conservation

Coral Cay Conservation (CCC) is a not for profit organisation, founded in 1986 by a British scientist. CCC's mission is:

"Providing resources to help sustain livelihoods & alleviate poverty through the protection, restoration & management of coral reefs & tropical forests."

In order to achieve this mission, CCC has carried out conservation projects all over the world, including in the Philippines, Belize, Honduras, Malaysia, Cambodia and Fiji. CCC successfully set up Marine Protected Areas and provided scientific data that has been used to manage local marine resources. The project in Danjungan Island in the Philippines between the years 1996-1999 was particularly successful and the reefs around the island received the accolade of Best Managed Reef in the Philippines in 2002. Since 1995, CCC has worked with the Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and local communities to survey and safeguard reef and rainforest areas in the Philippines. To date these have included coastal regions of the Southern Negros Occidental, Anilao, Palawan, Danjungan Island and the forests of North Negros.

At the invitation of the Provincial Government of Southern Leyte, CCC began its survey work in Sogod Bay in September 2002. CCC is conducting a collaborative program to survey the region's coral reefs and provide training and conservation education opportunities for project counterparts. The aim is to develop local capacity and ensure the long-term protection and sustainable use of marine resources throughout Southern Leyte.

1. Introduction

1.1. Marine Protected Areas

Marine resources have come under increasing pressure from an ever growing world population (Jackson, et al. 2001). Strong declines in catch from fisheries worldwide, such as the North Atlantic Cod (Myers, et al. 2007) and reef fisheries in the Caribbean (Hardt 2009), have illustrated that biological marine resources are limited (Pauly, et al. 2002, Jackson, et al. 2001). Additional pressures such as pollution, coastal development and the effects of climate change contribute to the stress the marine environment is under. This has given rise to the increased drive for conservation efforts and resource management in the marine environment (Wood, et al. 2008, CBD 2010). Marine protected areas (MPAs) can achieve conservation and resource management targets simultaneously and are therefore considered instrumental to sustainable ocean utilization (Pauly, et al. 2002). The International Union for the Conservation of Nature (IUCN) defines a MPA as:

“A clearly defined geographical space, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with the associated ecosystem services and cultural values.”

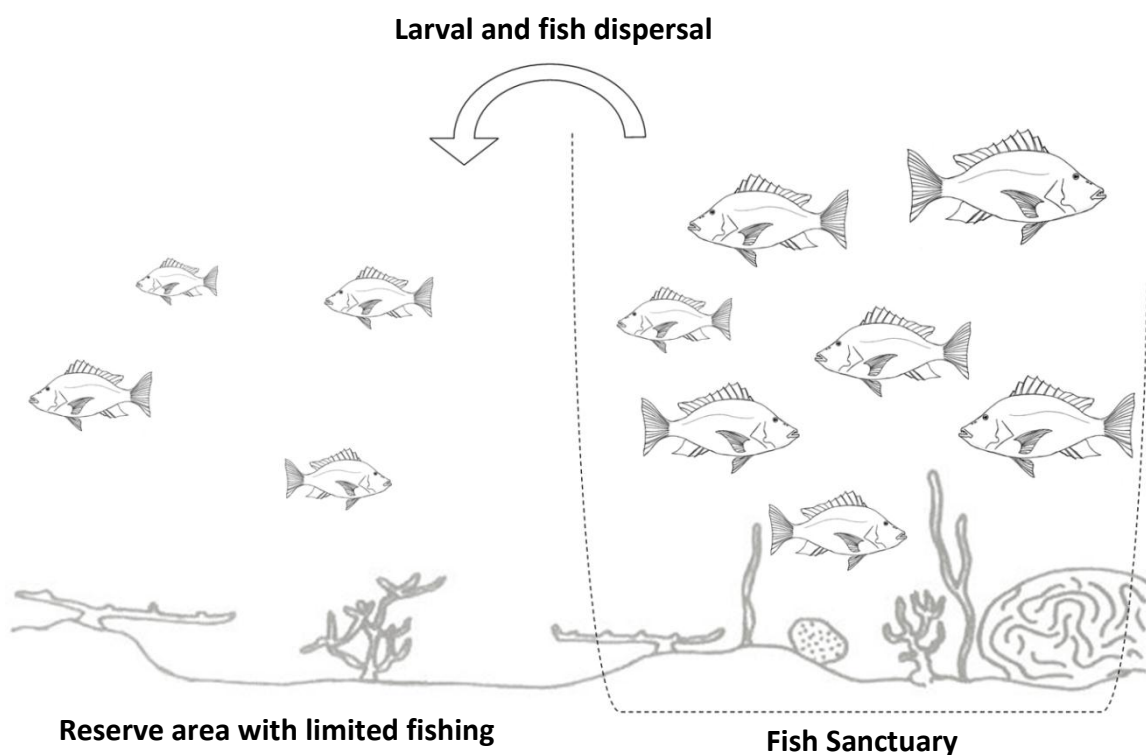


Figure 1 – Schematic diagram of MPA functioning. Protected fish in the MPA grow larger and produce more offspring, this leads to ‘overspill’, increasing fish numbers outside the MPA. In addition, the corals inside the MPA are not disturbed by direct human impacts.

MPAs have become vital tools in conserving marine resources, not only for their own intrinsic value but also for the services they can provide humanity. The ecosystem within the MPA, if left undisturbed for an extended amount of time, has the potential to provide a sustainable supply of goods - such as fish, algae and salt - and services - such as shoreline protection, maintaining water quality and recreation (World Bank 2005). Increased fish catch is perhaps the most sought after potential benefit of MPAs. There are two ways that this can happen, through overspill and larval export (Figure 1).

However, the success of MPAs is for a large part dependent on the willingness of local people to adhere to the rules. Experience from around the world has shown that closely involving local people in the planning, implementation and management of their own MPA can increase their sense of ownership and pride. Only when the local stakeholders feel their concerns are taken seriously and they are consulted on management of the MPA regularly, will it be possible for the full beneficial potential of the MPA to be attained (Green, et al. 2009, Human and Davies 2010).

1.2. Coral Reefs & Marine Conservation in the Philippines

The Philippines lies within a region known as the Coral Triangle. The Coral Triangle, which includes Indonesia, Malaysia, Papua New Guinea, Timor-Leste and the Solomon Islands, is recognized as the global centre of marine biodiversity (Roberts, et al. 2002). It is home to the oldest coral reefs in the world and the largest expanses of mangrove forest. More than 75% of the known coral species and over 30% of all the coral reefs in the world are found in the Coral Triangle (Veron, et al. 2009). The same extraordinary diversity is found in the other types of marine creatures; with over 3,000 species of fish recorded, even higher figures for molluscs and new species still being discovered regularly (Allen 2008).

The waters of the Philippines contain roughly 25,000 km² of coral reefs. An estimated 60% of the country's 92 million citizens live in coastal regions, i.e. in close proximity to coral reefs, and over half of the consumed animal protein comes from marine sources (CTI 2012). This heavy reliance on marine resources has caused large areas of coral reef ecosystems to become threatened. In 1980 33% of coral reefs were characterized as being in poor condition, in 2008 this figure had increased to 40% (Wilkinson 2008). These figures make a strong case for increased marine conservation efforts. Legislation concerning marine conservation in the Philippines is probably one of the most advanced within the Coral Triangle (Jacinto, et al. 2000). Some important laws include:

- 1998 Fisheries Code (Republic Act 8550): 15% of municipal water should be within a MPA

- Marine and Coastal Resource Protection Act: Each municipality should have at least one MPA that is bigger than 10 hectares (if the total municipal waters are larger than 15 hectares)
- The Philippine Marine Sanctuary Strategy (2002): By 2020, 10% of all the Philippine marine waters will be fully protected

Currently there are about 1,640 MPAs in the Philippines. Of these MPAs, 33 have been declared at national level as NIPAS sites and the remainder is managed by Local Government Units (LGU) (DENR-CMMO presentation, March 19 2013). Box 1 highlights a case study of successful MPAs in the Philippines.

Box 1 - Case study of successful MPAs in the Philippines: Apo Island & Sumilon Island

The MPAs at Apo Island and Sumilon Island are some of the best-known examples of successful tropical marine conservation efforts in the world. Years of monitoring have provided accurate data that shows what can be achieved if the coral reef inside a MPA is given the chance to recover (Figure 2). These figures also show that although an increase of biomass was observed in the first years of reserve protection, the biggest increase in biomass took several years to become evident (5-10 years). Unequivocal evidence of overspill from these MPAs remains elusive but the increased number and size of fish within the reserve make it likely that the MPA is a source for net larval export, which can aid recovery of fish stocks in the area. Indirect positive effects of the effective management of these MPAs include increased tourism income and elimination of unsustainable fishing practices such as dynamite fishing (Russ and Alcala 2004).

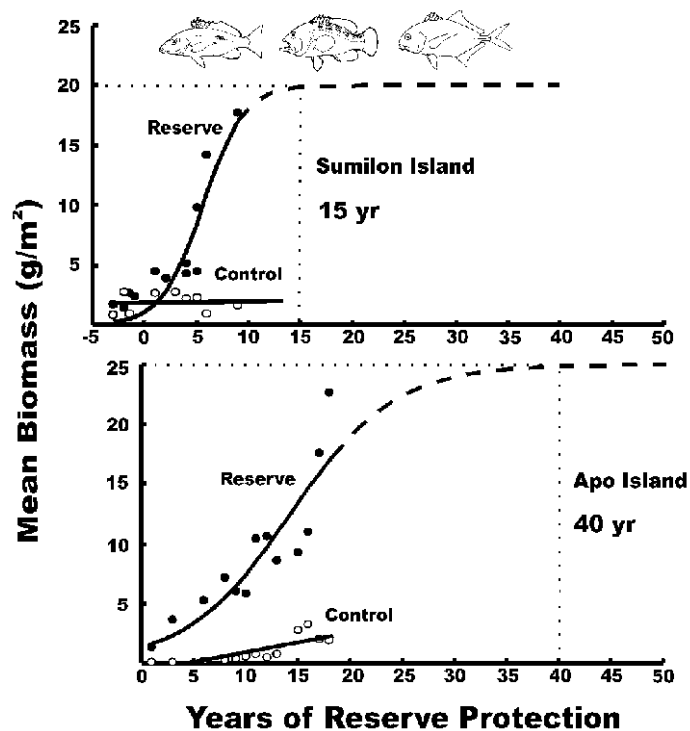


Figure 2 - Observed and projected increase in mean biomass of commercially important species of fish inside the MPAs at Apo Island and Sumilon Island.
Figure from: Russ and Alcala (2004).

1.3. Characterization of Study Region

1.3.1. *Sogod Bay*

The coral reefs of Southern Leyte remain some of the least disturbed habitats in the Philippines. Sogod Bay is an important fishing ground and the area is rich in tuna, flying fish, herrings, anchovies, shell-fish and Spanish mackerel. The bay has been targeted by the Fisheries Sector Program of the Department of Agriculture as one of the country's ten largest bays in need of assessment and management (Calumpong, et al. 1994). Sogod Bay is also a feeding ground for attractive mega-fauna such as pilot whales, melon-headed whales, dolphins, manta rays and whale sharks. The bay is characterised by naturally limited mangrove areas, narrow fringing coral reefs, limited seagrass beds and narrow intertidal areas and beaches (Calumpong, et al. 1994). Depths in the bay reach a maximum of approximately 1,400 metres in the central channel.

Currently there are 23 established MPAs within Sogod Bay covering an estimated 170 hectares. These figures will increase in the coming years as more MPAs are currently being set up. The size of the MPAs ranges from 2 hectares (Maujon/Juangon Fish Sanctuary) to 45 hectares (Limasawa Fish Sanctuary), with a mean average size of 8.7 hectares (± 2.1 SE) and a median average of 5 hectares. The sizes for several MPAs are not known, as accurate GPS coordinates are not available.

1.3.2. *Napantao MPA*

The Napantao MPA, was established in 1996 and covers 5 hectares. It is located in the Municipality of San Francisco, in the waters of the barangay Napantao. The barangay is home to around 300 people, of which 25 are fishers. The boats used by the local fisherfolk are mostly non-motorised. The MPA is to the east of the village (Figure 3). There is a Bantay Dagat hut which is permanently supervised. Currently, the MPA infrastructure is very good (Table 1). Fishing takes place in the area surrounding the MPA on a regular basis but poaching inside is rare (Bantay Dagat, Pers. Comms).

Table 1 - Summary of MPA infrastructure at Napantao MPA

MPA Infrastructure	Present?
Trained Bantay Dagats	✓
Permanent Bantay Dagat presence	✓
MPA guardhouse	✓
Demarkation buoys	✓
Patrol boat	✓
Bantay Dagat gear (flashlight, fins, mask, etc.)	✓
User fees collected	✓

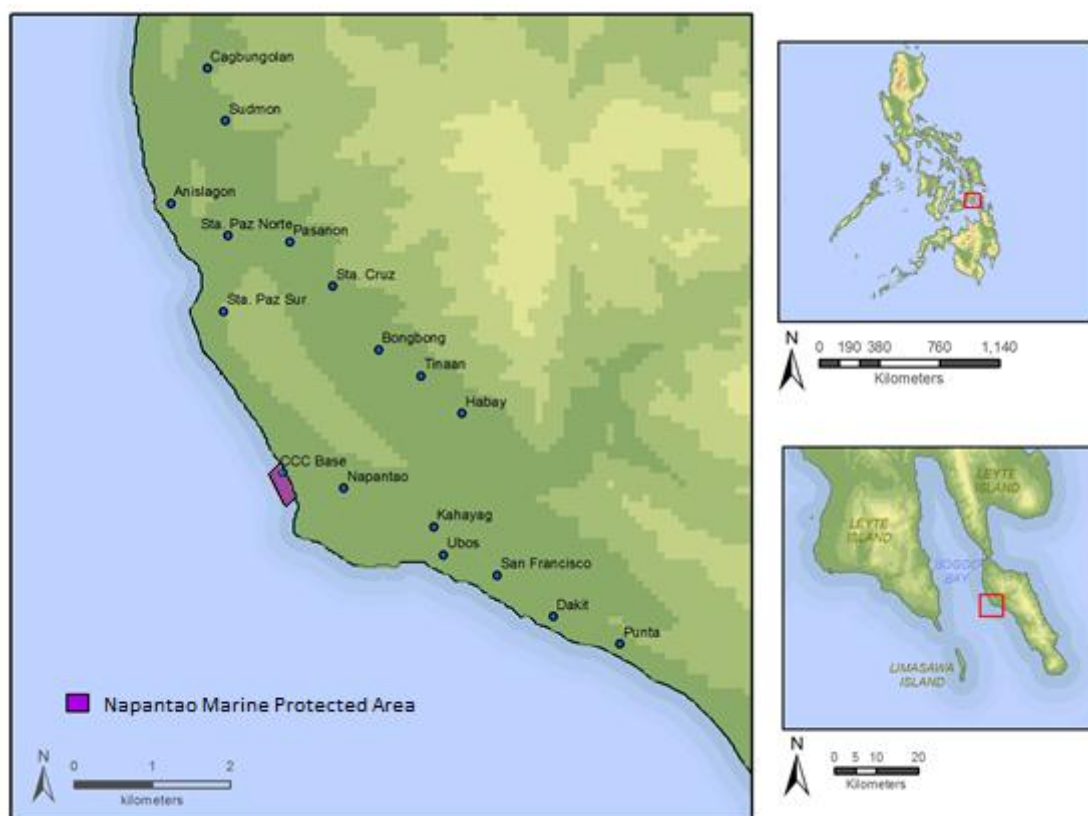


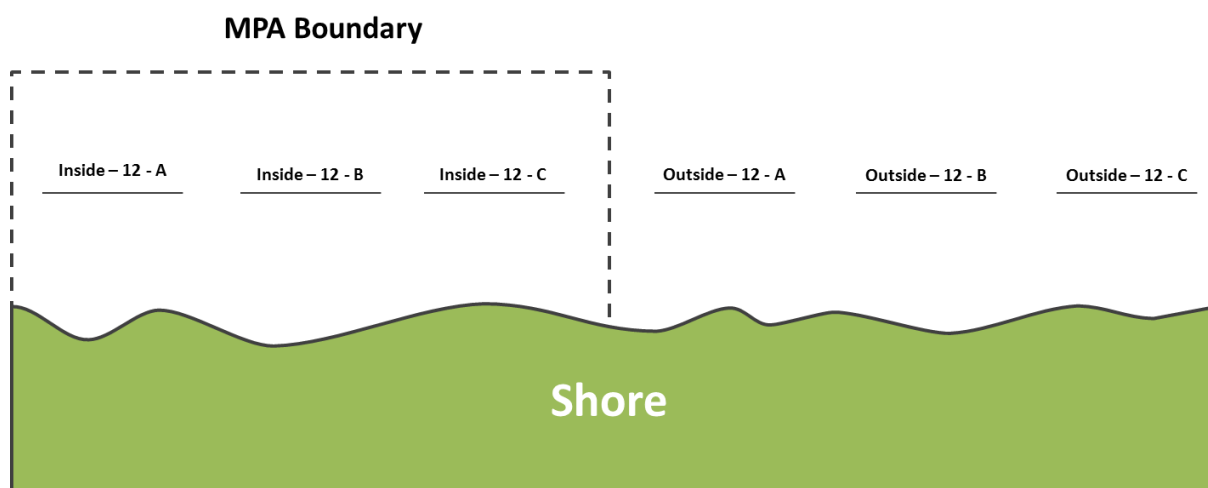
Figure 3 - Map showing the location of Napantao Marine Protected Area

2. Methods

2.1. Biophysical Survey

The assessment of the MPA was conducted using an enhanced Reef Check method. The Reef Check methodology is widely recognised and is used to survey coral reefs around the world. It was developed in the 1990s with the aim of gathering as much data as possible about the global status of coral reefs (Hodgson 1999). The data from around the world is analysed on a yearly basis and updates about the status of coral reefs are published. Reef Check provides a general picture of the ecological status of a reef and the human impacts affecting it. CCC has augmented the methodology by adding additional target species of fish, coral and other invertebrates to better reflect the high biodiversity of the area (see Appendix A for target species).

Survey transects were conducted at depths of 12 metres, both inside and outside the MPA (Figure 4). Each transect was 100 metres long and divided into 4 replicates of 20 metres each. Between each replicate there was a 5 metre gap where no data was recorded. This survey set up allows for robust statistical analysis of the collected data.

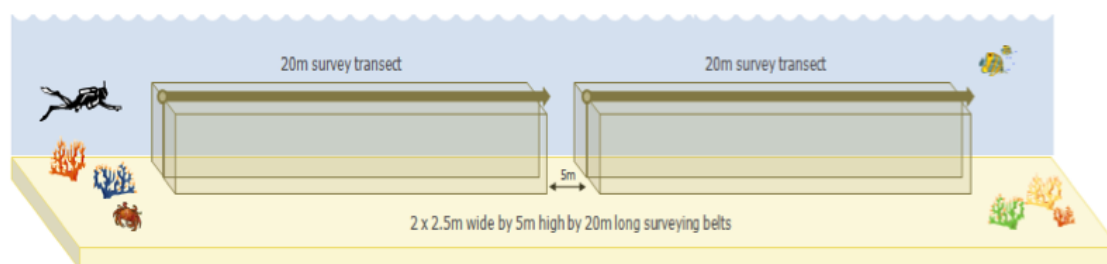


*Figure 4 - Survey plan of the MPA assessment.
Each transect was 100 meters long and is divided into 4 20m replicates.*

2.1.1. Fish

The fish diversity and abundance data was collected using Underwater Visual Census. Selected fish families and species recognized as being good indicators of fishing pressure, aquarium collection and reef health were recorded. Three families of commercially important fish were also recorded by size: Groupers (Lapu Lapu, Serranidae), Parrotfish (Mulmul, Scaridae) and Snappers (Maya Maya, Lutjanidae).

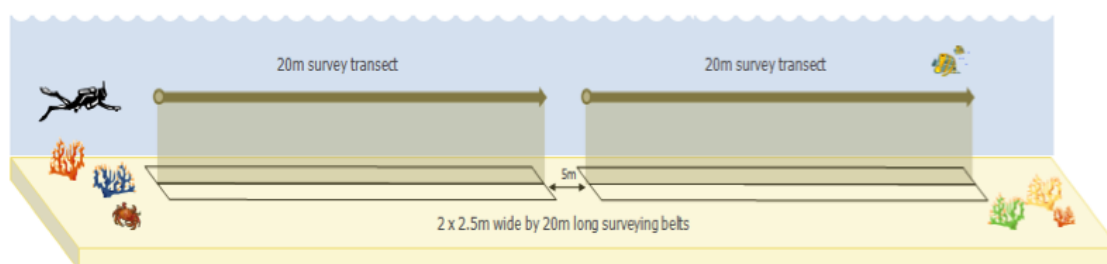
Fish data was recorded along a 'belt' transect, where fish were counted within an imaginary 5x5x5m box along the four 20m replicates (Figure 5). Surveying was carried out by two divers swimming slowly side by side along the transect and counting the indicator fish. The divers stopped every 5 metres and waited 1 minute for the indicator fish to come out of hiding before proceeding to the next 5 metre stop-point.



*Figure 5 - Survey method for recording fish.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.2. Invertebrates

The same areas used for the fish belt transect were used to record the diversity and abundance selected invertebrate species typically targeted as food species, collected as curios or important to the ecological balance of the reef. The divers recorded invertebrates 2.5m either side of the transect line (Figure 6). Divers looked in holes and under overhangs to look for organisms such as lobsters, sea urchins or other cryptic species.

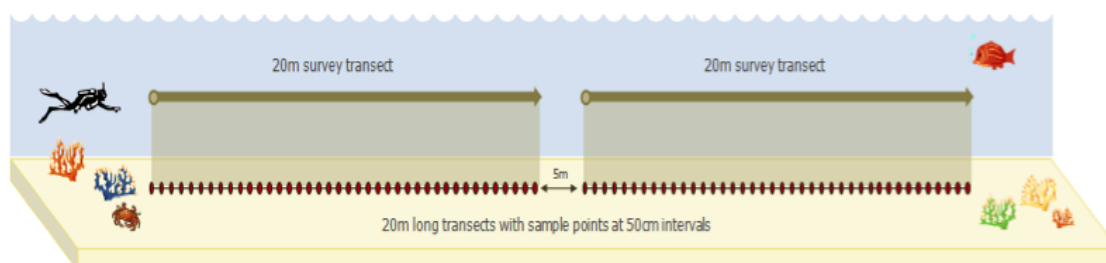


*Figure 6 - Survey method for recording invertebrates.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.3. Substrate

Benthic diversity was measured by recording living and non-living benthic categories along a point intercept transect. Along the transect line, benthic organisms and substrate types were recorded at 50cm intervals (Figure 7). To minimize bias, a plumb line was dropped at each designated 50cm point and the substrate type underneath was recorded. Every replicate contained 40 benthic points.

Benthic categories were: sand, rock, rubble, silt/mud, nutrient indicator algae, sponge, recently killed coral, soft coral, hard coral and any other biotic lifeforms. Hard corals were further classified by lifeform and certain targets were also noted to genus or species level (see Appendix A).



*Figure 7 - Survey method for recording substrate data.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.4. Impacts

Within the same area assessed for invertebrates divers recorded a number of impacts on the reef. They estimated the total percentage of bleached coral cover as well as the estimated percentage of each individual coral colony that was bleached. Coral diseases were recorded as a percentage of the colony infected and where possible, the disease was identified. Damage was recorded in three categories: boat/anchor, dynamite and other, on a categorical scale from 0 to 3 (0 = none, 1 = low, 2 = medium, 3 = high). Impact on the site from trash was recorded on the same scale and separated into general and fishing nets/traps.

2.2. Data Analysis

Each 20m belt transect was treated as an independent replicate. This produced $n=12$ inside the MPA and $n=12$ outside the MPA. To test for statistically significant differences between inside and outside the MPA, Mann-Whitney U tests were used. Preliminary inspection of the data revealed that the variances were not homogeneous and the data had a non-normal distribution. Transformations of the data did not sufficiently alter this to warrant using a parametric test.

Species diversity of fish and invertebrates was calculated using the Fishers α index. These index values too were then submitted to the Mann-Whitney U test to check for significant differences.

3. Results

The assessment of the Napantao MPA was conducted between the 7th of March 2013 and the 22nd of April 2013. It was conducted over 24 dives by trained volunteer survey teams from Coral Cay Conservation. In general, the weather was sunny with some periods of cloudy skies. On average the air temperature was 31°C. The water temperature was on average 28°C at the surface and 27°C at a depth of both 3m and 10m. Average estimated underwater horizontal visibility was 21m.

3.1. Fish

Overall mean fish abundance inside and outside the MPA was 150.5 ± 21.5 per 500m³ and 175.4 ± 23.7 per 500m² (mean $\pm$ SE) respectively (Figure 8a). The difference in abundance

between inside and outside was not found to be significant. The overall abundance of Grouper (Serranidae) was significantly higher inside the MPA than outside ($4.8 \pm 0.8 : 1.5 \pm 0.5$ per 500m^3 respectively, $p= 0.001$). Butterflyfish (Chaetodontidae) were also significantly more abundant inside the MPA compared to outside ($16.3 \pm 1.4 : 10.5 \pm 1.9$ per 500m^3 respectively, $p= 0.02$) (see Figure 24 in Appendix B).

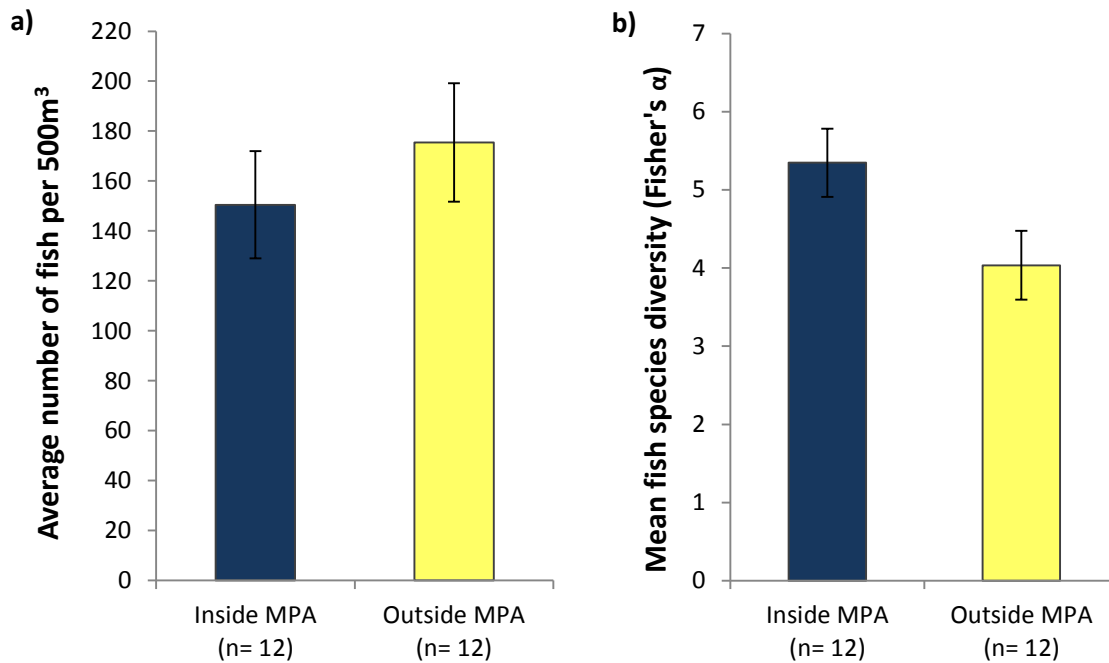


Figure 8 - Average abundance (a) and diversity (b) of fish inside and outside the MPA. Data are mean average per replicate, error bars are standard error of the mean.

The overall diversity of fish families was not significantly different between inside and outside the MPA (5.35 ± 0.44 and 4.03 ± 0.44 respectively, Figure 8b). The average number of Butterflyfish species recorded inside the MPA (4 ± 0.6 per 500m^2) was significantly higher than outside (2.2 ± 0.3 per 500m^3) ($p= 0.02$). When considering Fisher's α diversity index for Butterflyfish species, the difference was not significant. Over the entire survey area there were some notable absences of some species and families, including Sweetlips (Haemulidae) and Humphead Wrasse (Cheilinus undulatus). Other families including Emperors (Lethrinidae) and Jacks (Carangidae) were observed in very low numbers (<1 per 500m^2). 98% of Groupers and Snappers observed were under 30cm in length. No sharks, rays or sea snakes were recorded but one turtle was observed inside the MPA.

In general individual Groupers recorded inside the MPA were larger than those recorded outside. Of the individuals recorded outside the MPA, 61% were 10cm in length or less, while inside the MPA 64% were 11cm in length or greater, the majority being 11-20cm in length (Figure 9). Very few individuals over 20cm in length were recorded either inside or outside the MPA (5 inside and 1 outside in total over all transects), and no groupers over 40cm were recorded at all.

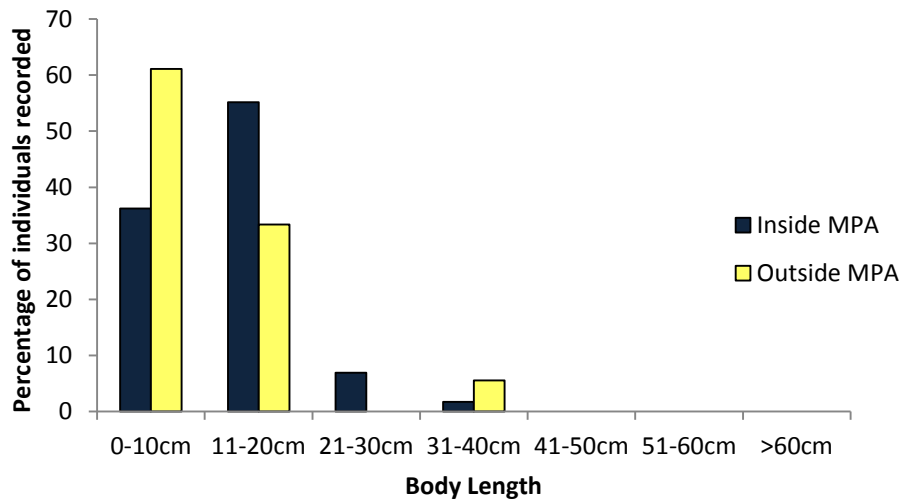


Figure 9 - Percentage of Groupers recorded in different size classes inside and outside the MPA

3.2. Invertebrates

The average overall abundance of invertebrates inside and outside the MPA was 157.7 ± 13.6 per 100m^2 and 142.2 ± 15.8 per 100m^2 respectively (Figure 10a). The difference in abundance was not found to be significant. Two families were found in significantly different abundances between inside and outside the MPA. Cone shells (*Conus* sp.) were more abundant outside the MPA (outside: 2.0 ± 0.5 per 100m^2 , inside: 0.42 ± 0.1 per 100m^2 , $p = 0.004$). *Drupella* species were found to be significantly more abundant inside the MPA (inside: 10.8 ± 2.1 per 100m^2 , outside: 5.8 ± 2.2 per 100m^2 , $p = 0.02$).

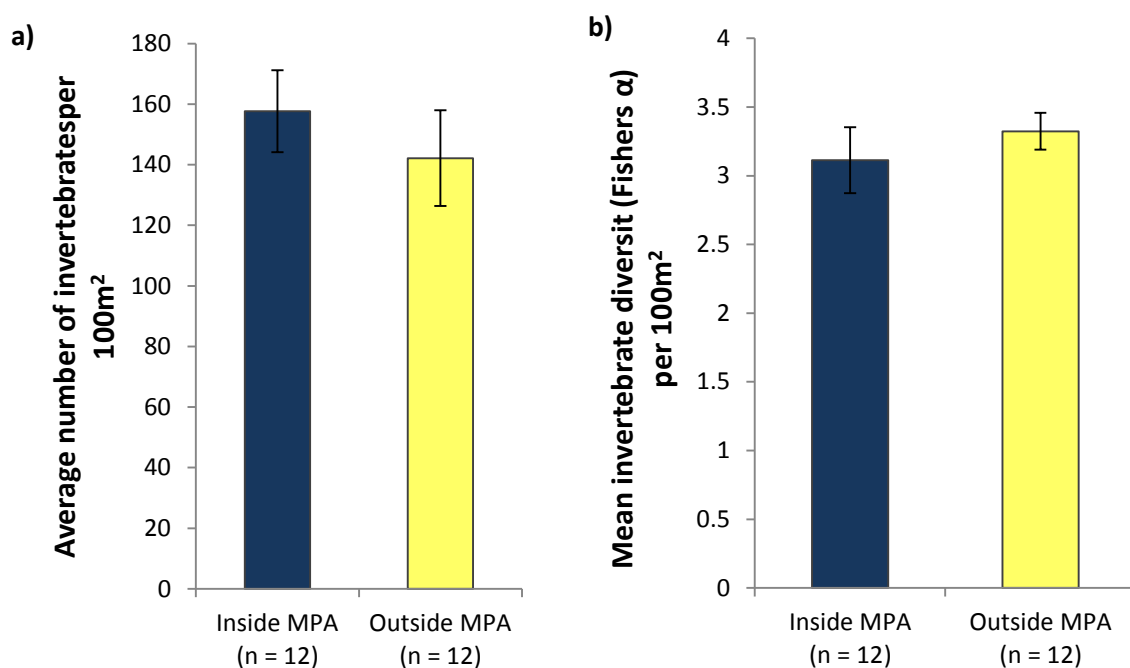


Figure 10 - Average abundance (a) and diversity (b) of invertebrates inside and outside the MPA. Data are mean average per replicate, error bars indicate standard error of the mean.

There was no significant difference in the diversity of invertebrates observed inside and outside the MPA (3.11 ± 0.24 and 3.32 ± 0.13 respectively, Figure 10b). Several commercially important species or families were wholly absent from the survey. These include Triton's Trumpet (*Charonia tritonis*), Squid (Teuthida) and target species of sea cucumber including Prickly Red Fish (*Thelenota ananas*) and Greenfish (*Stichopus chloronotus*) (see Figure 25 in Appendix C). Giant clams (*Tridacna* sp.) were recorded both inside and outside the MPA, 9 and 7 in total, respectively. Individuals were all generally small, <30cm. Crown of Thorns starfish were recorded in very low numbers both inside and outside the MPA (0.5 ± 0.19 and 0.5 ± 0.28 per 100m² respectively).

3.3. Substrate

Inside the MPA the most commonly recorded substrate was hard coral followed by rock while outside the MPA hard coral was most common followed by sand and rock (Figure 11).

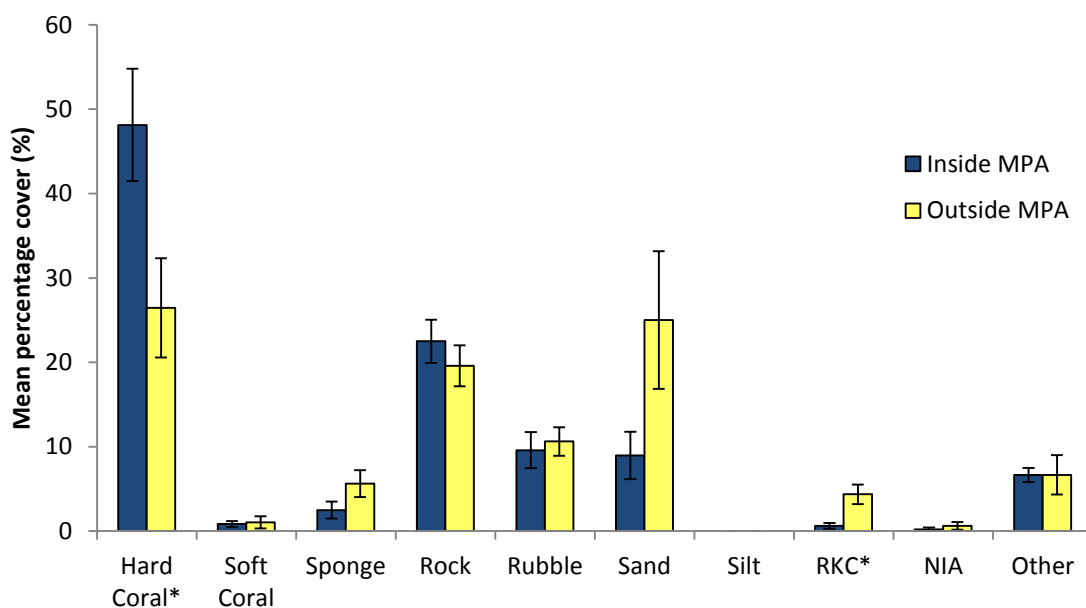


Figure 11 - Mean percentage cover of substrate types inside and outside the MPA. Values are mean averages, error bars are Standard Error of the mean. RKC = Recently Killed Coral, NIA = Nutrient Indicator Algae. Categories marked with (*) indicate significant difference between inside and outside the MPA.

The percentage cover of hard coral was significantly higher inside the MPA than outside ($p=0.02$), 48.13 ± 6.66 % and 26.46 ± 5.87 %, respectively (Figure 11). Inside the MPA 25 target species of hard coral were recorded. Outside the MPA 20 target species of hard coral were recorded. The most commonly recorded coral category inside was *Acropora* branching. Outside the MPA it was Non-*Acropora* sub-massive. Both inside and outside the MPA the most commonly recorded target species of hard coral was massive *Porites* sp. Inside,

Ctenactis echinata and *Seriatopora hystrix* were also common, with *Lobophyllia* common outside (see Figure 26 in Appendix D)

Recently Killed Coral whilst only observed in a low abundance had a significantly higher percentage cover outside the MPA than inside ($p = 0.04$), $4.38 \pm 1.16 \%$ and $0.63 \pm 0.33 \%$, respectively (Figure 11). Nutrient Indicator Algae was observed in very low abundance both inside and outside the MPA.

3.4. Anthropogenic Impacts

Anthropogenic impacts were low across the survey area. There was no evidence of either boat or anchor damage to coral and no instances of coral damage related to dynamite fishing were recorded. Trash was observed infrequently both inside and outside the MPA. No trash classed as 'fishing related' was recorded inside the MPA. Overall levels of fishing trash were classed as 'low' outside the MPA though on two of the twelve replicates a 'medium' level of this impact was recorded. Household trash was found both inside and outside the MPA at a low level. 'Other' coral damage, predominantly caused by predation by corallivorous animals, was classed as 'medium' inside the MPA with four of the twelve replicates exhibiting a 'high' level of this impact. Outside the MPA the level of this impact was between 'low' and 'medium' with three replicates exhibiting 'high' levels. The majority of this predation was attributed to *Drupella* sp. Evidence of predation by Crown of Thorns starfish was low across the survey area with only one instance inside and one instance outside the MPA. Coral bleaching was recorded at a low level on all transects ($<0.02\%$ of the population in all instances). No coral disease was observed throughout the assessment.

4. Visual Assessment

The following section contains images of the reef and marine creatures found within the Napantao MPA.



Figure 12 - Coral reef inside the Napantao MPA



Figure 13 - Coral reef inside the Napantao MPA



Figure 14 - Coral reef inside the Napantao MPA



Figure 15 - Coral reef inside the Napantao MPA



Figure 16 - School of Unicornfish (Naso sp.) inside the Napantao MPA



Figure 17 - A tree soft coral inside the Napantao MPA



Figure 18 - Olivar's Squat Lobster, Munida olivarae, inside the Napantao MPA



Figure 19 - Warty Frogfish, Antennarius maculatus, inside the Napantao MPA



Figure 20 - White ring noumea, *Noumea alboannulata*, inside the Napantao MPA



Figure 21 - Psychedelic batwing slug, *Sagaminopteron psychedelicum*, inside the Napantao MPA



Figure 22 - Peacock Mantis Shrimp, *Odontodactylus scyllarus*, inside the Napantao MPA



Figure 23 - A CCC volunteer collecting substrate data along a transect line inside the Napantao MPA

5. Discussion

The assessment of the Napantao MPA and the area adjacent to it gave the overall impression of a healthy reef ecosystem. There are some trends that are of concern and require consideration to ensure the continued condition of the reefs in the area. However, there are also encouraging signs that the MPA is having a positive impact on the reef ecosystems at Napantao. In this section the trends observed in the data are discussed and recommendations for future management are provided.

5.1. Fish

The overall trends in the abundance of fish between inside and outside the MPA were not significantly different. However, when considering individual target species, including commercially important species such as grouper and ecological indicator species such as butterflyfish, significant differences were observed. Grouper abundance inside the MPA was significantly higher than outside. This is a positive indicator that the MPA is providing refuge for highly targeted species, and may suggest the MPA is achieving a conservation objective of enhancing fish stocks.

Grouper, along with other commercially important reef fish families such as Snappers, are often very long lived and slow growing, with life spans often ranging from 25 to 40 years (Coleman, et al. 2000). These, so-called 'life history' traits impact heavily on the population replacement rates of these fish. Most Grouper species take a long time to reach sexual maturity and their reproductive capacity is greatly affected by size, which is in turn directly related to age. Within breeding aggregations of the Squaretail Coral Grouper for example, studies found that, on average, females were 46cm in length and males 54cm, meaning that each breeding individual was likely over 5 years in age (Rhodes and Tupper 2008). This size/age-fecundity relationship is often very pronounced: studies of the Gag (*Mycteroperca microlepis*), a member of the Serranid family, showed that 8 year old individuals produced 48 times the number of eggs of 3 year old individuals (Collins, et al. 1998). In addition, Sdaovy *et al.* (1994) showed that gonad size in another species of grouper, the Red Hind (*Epinephelus guttatus*), is positively correlated to body size, with larger individuals having larger gonads and therefore higher reproductive capacity. In addition to having higher fecundity, larger individuals may also play a disproportionately important role in the dynamics of grouper populations. Many species of grouper exhibit protogynous hermaphroditism, the ability of individuals to change sex from female to male in order to regulate population dynamics. In these instances, significant percentages of the population are female, with male to female ratios often between 1:3 and 1:4 (Sadovy, Rosario and Roman 1994, Rhodes and Tupper 2008). Upon attaining sufficient size and if the current sex

ratios are favourable, a large female will turn into a male. This strategy is beneficial as it allows one male to breed with many females when, at a larger size, it has sufficient fecundity to do so. The result of all of these life history traits is that species such as grouper are particularly susceptible to overfishing. Not only does it take these slower growing species a long time to recover when their population is decreased by extraction, but preferential selection of larger individuals by fishermen also reduces the fecundity of the population as a whole and can disrupt sex ratios and population dynamics.

The low overall numbers of groupers, as well as the lack of individuals over 30cm in length, recorded both inside and outside the Napantao MPA is indicative of historical overfishing in the area. Understanding the life history traits outlined above, it is evident that any recovery of these species within the MPA is going to be slow. However, the significantly higher numbers of individuals recorded inside the MPA and their larger average size, is an extremely positive sign indicating that this recovery is underway.

5.2. Invertebrates

The abundance of invertebrates was not found to be significantly different between inside and outside the MPA. Of all the target species recorded only two species of gastropod; Cone shells and *Drupella* sp., were observed in significantly different abundance. These differences are likely due to observed differences in substrate cover between inside and outside the MPA. Cone shells are commonly associated with soft sandy substrates as they largely predate on other small gastropods and invertebrates found in these areas. Conversely, *Drupella* predate on coral polyps and so commonly associate with areas of high hard coral cover. Thus, the higher prevalence of sand outside the MPA and hard coral inside the MPA reasonably explain these differences.

A more worrying result from the data is the lack of many commercially important species of invertebrates such as Triton's Trumpet, Squid and species of sea cucumber. These species, which in many cases are slow growing and slow moving, are particularly vulnerable to over exploitation. Giant Clams, another important commercial species, were observed on the surveys but in low numbers. Furthermore, all the individuals observed were less than 30cm in length. These results indicate that extraction pressure may be high in areas surrounding the MPA and that for certain species the MPA is not enhancing stocks. This could be as a result of historical fishing pressure removing all individuals from the area prior to the establishment of the MPA. The fact that small giant clam were recorded on the survey may indicate that for this species, recruitment of new individuals is occurring but at a slow rate.

Crown of Thorns Starfish (CoTs, *Acanthaster planci*) were recorded both inside and outside the MPA. This seastar is a voracious predator of corals and at high levels of abundance can

cause catastrophic damage to reef communities. Fortunately the total number of observed CoTs on the survey was low and presents no cause for alarm. At low abundance levels CoTs are a natural part of reef systems and actually play a vital role in maintaining healthy, diverse coral communities. By feeding on diseased coral and preferentially predating fast-growing species such as *Acropora* (Pratchett 2005), they help control the spread of disease and increase competition between coral species leading to higher diversity.

5.3. Substrates

The differences in substrates recorded inside the MPA compared to outside are attributed to natural variation. The area outside the MPA is characterised by sand interspersed with rock outcrops. Inside, a greater quantity of rock was recorded. Coral requires a hard substrate on which to settle and grow. Therefore sand is a poor substrate for coral recruitment and this explains the lower abundance of hard coral outside the MPA. Furthermore, the greater abundance of hard coral inside the MPA can be attributed to the greater quantity of hard substrate such as rock.

Indicators of coral health including nutrient indicator algae, evidence of recently killed coral, bleaching and coral disease were observed in only a few instances or were totally absent from the survey area. From these observations it is possible to conclude that the reef inside and adjacent to the MPA, in terms of hard corals is in good condition. Recently killed coral was found to be significantly more abundant outside the MPA, however this is more a reflection of the fact that only two instances were recorded over the entire survey area inside the MPA. The value for outside the MPA is still low and of little concern.

The overall high quantity and good health of hard coral inside the MPA and in the surrounding area means that the Napantao MPA remains one of the best dive sites in Southern Leyte. Tourist boats are frequent visitors to the MPA and this is largely due to the abundant hard coral and diversity of species. The role of tourism for the future of the MPA is discussed further in Section 6.

5.4. Impacts

Although signs of anthropogenic impacts such as coral damage from boats or trash were low across the survey area, there are indicators that other impacts including fishing pressure are high around the MPA. Due to the effective enforcement of the MPA by Bantay Dagat, illegal poaching inside is rare. However fishing does occur in the immediate vicinity of the MPA and up to the boundary (*Bantay Dagat, Pers. Comm.*). This is a necessity for the local fisher folk who rely on the fishing grounds around the MPA for food and income. This level of

fishing does however place a sustained pressure on the MPA. Many fish species such as Fusiliers (Caesionidae) and Jacks (Carangidae) are extremely mobile, travelling over large distances in search of food. As a result the ability of a small MPA such as Napantao to protect such species is limited. Contrary to this, other species including Grouper can be more geographically restricted and will associate to particular habitats or home ranges. As discussed in Section 5.1 the significantly higher abundance of Grouper inside the MPA suggests that for less wide ranging species, the MPA is mitigating the fishing pressure and increasing fish stocks. It is vital that the enforcement remains high in order to continue this trend. Just a few instances of poaching inside the MPA can destroy years of recovery in a relatively short period of time (McCook, et al. 2010).

The higher abundance of Grouper inside the MPA is a positive sign. However, the overall abundance of all commercially important species of both fish and invertebrates was low both inside and outside the MPA. Furthermore those individuals observed were all generally small indicating a population structure dominated by juveniles and small adults. This trend is troubling and may indicate that pressure from fishing is removing the large individuals of keystone species that are vital for the control of species diversity and maintaining a balanced ecosystem. It could, however, be an indicator that fishing pressure has been high in the past since any recovery from intensive overfishing will be slow. On-going monitoring of the MPA over time will help to give an impression of trends in population dynamics over time and highlight on-going threats to the coral reef ecosystems within the MPA.

The removal of important species of herbivorous fish such as Parrotfish (Scaridae), Rabbitfish (Siganidae) and Surgeonfish (Acanthuridae) through overfishing, can cause additional impacts to an ecosystem, such as phase shifts from coral dominated ecosystems to ones dominated by fleshy algae. Herbivorous fish help control the abundance of algae in reef systems by constantly grazing new growth. If grazing species of fish are removed, competition for algae is reduced and thus there is a corresponding increase in other grazers including *Diadema* urchins. An increase in *Diadema* numbers in itself is not a problem as they are effective grazers and will fill a similar ecological niche as the removed fish species. Nevertheless, in a number of cases worldwide *Diadema* have exhibited mass die-off caused by disease (Lessios, Robertson and Cubit 1984). It is theorised that when numbers increase rapidly the proximity of individuals leads to disease outbreak (Bellwood, et al. 2004). Without any grazing pressure, macro-algae are able to grow rapidly. As coral species are easily outcompeted by algae this can lead to a reduction in coral cover and a shift to an algal dominated ecosystem capable of supporting a far lesser abundance and diversity of species (McClanahan, et al. 1996). Even if herbivore numbers were to increase again a later stage, reversing this phase shift i.e. going back to a coral dominated reef, is extremely difficult (Lotze, et al. 2006). *Diadema* numbers were generally low on the surveys suggesting that at present competition for algae from herbivorous fish is high.

Whether indirect or direct the effects of over fishing can be extremely serious. The actual relationships between organisms of different trophic levels are very complex and scientific understanding is limited. However, cases of trophic cascade and phase shift have both been recorded on reefs around the world where overfishing has played a role in the reduction of fish stocks (Bellwood, et al. 2004).

6. Recommendations

The presence of permanent Bantay Dagat at the Napantao MPA means that compliance and enforcement are strong within the boundaries. Furthermore, infrastructure and equipment, such as a guard house, marker buoys, flashlights and a patrol boat are all in place and mean that the management of the MPA is currently effective. Since CCC moved to Napantao in 2008 we have conducted numerous awareness and education events within the barangay and the municipality as a whole. This has in part helped maintain the existing sense of pride and ownership exhibited by the local community and raised the level of understanding and institutionalization of the MPA. This continued support will help the MPA to develop and remain one of the preeminent dive sites within Sogod Bay and Southern Leyte.

It is highly recommended that ecological monitoring of the MPA continues on a regular basis. On-going monitoring of the reefs within the MPA and around its borders will provide data to indicate whether management measures continue to be successful and will highlight new natural or anthropogenic threats to the reefs. Knowing the ecological status of the reef will enable adaptive management to be practiced, ensuring that management measures are responsive to the current situation. Additionally, long-term datasets will enable the study of temporal changes on the reefs within the MPA and will provide evidence as to whether the MPA is achieving its conservation goals.

Tourism already provides some income to the local community through fees collected from dive tour operators that visit the MPA. Further development in this area could increase this and provide other alternative livelihoods. Any development however must be conducted with the protection of the reef as a primary concern. Too many divers on one site at one time can lead to the degradation of the reef through physical contact and irresponsible dive practices. Monitoring of the number of divers visiting the MPA in conjunction with ecological surveys should be used to help inform managers as to a sustainable level of tourism interaction.

Finally, the MPA Management Effectiveness Assessment Tool (MPA MEAT) was designed by the Philippine Government to allow managers and local communities to evaluate the effectiveness of their MPA and identify areas which need improving. Using simple criteria

and documented evidence, the current management situation of an MPA can be ascertained. This report should be used as part of the evidence for the Napantao MPA to help identify further areas that could be improved. Ultimately, the MPA is being managed effectively and community support is high. If this continues, the benefits of the MPA for both the health of the reef ecosystem and for the people who depend on it will increase.

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Appendix A: Target Species Lists

SUBSTRATES

Soft Coral	Sponge	Recently killed coral
Rock	Silt/mud	Rubble
Sand	Nutrient indicator algae	Other*
Hard Coral Lifeforms**:		
<i>Acropora</i> branching	<i>Acropora</i> encrusting	<i>Acropora</i> submassive
<i>Acropora</i> digitate	<i>Acropora</i> tabulate	Non- <i>Acropora</i> branching
Non- <i>Acropora</i> encrusting	Non- <i>Acropora</i> foliose	Non- <i>Acropora</i> submassive
Non- <i>Acropora</i> mushroom	<i>Heliopora</i> (blue coral)	<i>Millepora</i> (fire coral)
<i>Tubipora</i> (organ-pipe coral)		
*Other:		
Anemone	Corallimorph	Halimeda
Tunicate	Zoanthid	Gorgonian
Hydroids		

** If hard coral, also record target species

TARGET HARD CORALS

Brain small	Brain medium	Brain large
<i>Ctenactis echinata</i>	<i>Diploastrea heliopora</i>	<i>Echinopora</i>
<i>Euphyllia</i>	<i>Favia</i>	<i>Favites</i>
Foliose <i>Montipora</i>	<i>Galaxea</i>	<i>Goniopora/Alveopora</i>
<i>Herpolitha limax</i>	<i>Hydnophora</i>	<i>Lobophyllia</i>
Massive <i>Porites</i>	<i>Montipora digitata</i>	<i>Mycedium elephantotus</i>
<i>Pachyseris rugosa</i>	<i>Pachyseris speciosa</i>	<i>Pavona clavus</i>
<i>Pectinia lactuca</i>	<i>Plerogyra</i>	<i>Pocillopora</i> small
<i>Pocillopora</i> medium	<i>Pocillopora</i> large	<i>Polyphyllia talpina</i>
<i>Porites cylindrica</i>	<i>Porites nigrescens</i>	<i>Porites rus</i>
<i>Seriatopora hystrix</i>	<i>Tubastrea micrantha</i>	<i>Turbinaria</i>
Upside-down Bowl		

TARGET INVERTEBRATES

Feather duster worms	Christmas tree worms	Flatworms
Crabs	Shrimps	Banded coral shrimp
Lobsters	Nudibranch	Abalone
Conch	Cowrie	Triton's trumpet
Cone shell	Drupella	Top shell

Other gastropod	Giant clam	Octopus
Cuttlefish	Squid	<i>Acanthaster planci</i>
<i>Linkia laevigata</i>	<i>Culcita novaeguineae</i>	<i>Protoreaster nodosus</i>
<i>Choriaster granulatus</i>	Feather star	Brittle star
Long spine sea urchin	Pencil urchin	Collector urchin
Prickly redfish	Pinkfish	Greenfish
Other sea cucumber	Giant Clam	

TARGET FISH

Common Name	Latin Name	Visayan Name
Angelfish	Pomacanthidae	Adlo
Barracuda	Sphyraenidae	
Blenny	Blenniidae	
Butterflyfish*	Chaetodontidae	Alibangbang
Cardinalfish	Apogonidae	
(Damsel fish)	(Pomacentridae)	
Anemonefish	<i>Amphiprion</i> sp.	
Sergeant Damsel fish	Pomacentridae	
Emperor	Lethrinidae	Katambak
Filefish	Monacanthidae	Ilak
Fusilier	Caesionidae	Dalagang bukid
Goatfish	Mullidae	Timbongan
Goby	Gobiidae	
Groupers	Serranidae	Lapu-lapu
Flagtail Grouper	<i>Cephalopholis urodeta</i>	
Honeycomb Grouper	<i>Epinephelus</i> sp.	
Humpback Grouper	<i>Cromileptes altivelis</i>	
Lyretail Grouper	<i>Variola louti</i>	
Peacock Grouper	<i>Cephalopholis argus</i>	
Jack/Trevally	Carangidae	Talakitok
Lionfish	Scorpaenidae	
Lizardfish	Synodontidae	
Moorish Idol	<i>Zanclus cornutus</i>	Sanggowanding
Moral Eel	Muraenidae	
Parrotfish	Scaridae	Mulmul
Pipefish	Syngnathidae	
Porcupinefish	Diodontidae	
Pufferfish	Tetraodontidae	
Rabbitfish	Siganidae	Kitong
Virgate rabbitfish	<i>Siganus virgatus</i>	
Ray	Rajiformes	
Sandperch	Pinguipedidae	

Scorpionfish/Stonefish	Scorpaenidae	
Snapper	Lutjanidae	Maya-maya
Black and White Snapper	<i>Macolor macularis</i>	
Checkered Snapper	<i>Lutjanus decussatus</i>	
Two Spot Snapper	<i>Lutjanus biguttatus</i>	
Spade/Batfish	Ephippidae	
Spinecheeks	Nemipteridae	Silay
Twoline Spinecheek	<i>Scolopsis bilineatus</i>	
Squirrelfish/Soldierfish	Holocentridae	
Surgeonfish	Acanthuridae	Indangan
Unicornfish	<i>Naso</i> sp.	
Sweeper	Pempheridae	
Sweetlips	Haemulidae	Lipti
Toby	Tetraodontidae	
Triggerfish	Balistidae	Pakol
Trunk/Box/Cowfish	Ostraciidae	
(Wrasse)	(Labridae)	
Crescent Wrasse	<i>Thalassoma lunare</i>	
Humphead Wrasse	<i>Cheilinus undulatus</i>	
Red Breasted Wrasse	<i>Cheilinus fasciatus</i>	

*Target Butterflyfish

Vagabond Butterflyfish	Spot-Banded Butterflyfish	Merten's Butterflyfish
Klein's Butterflyfish	Dot and Dash Butterflyfish	Chevroned Butterflyfish
Latticed butterflyfish	Singular Bannerfish	Threadfin Butterflyfish
Eastern Triangle Butterflyfish	Longfin Bannerfish	Teardrop Butterflyfish
Redfin Butterflyfish	Masked Bannerfish	Spot-Nape Butterflyfish
Pyramid Butterflyfish	Pennant Bannerfish	Lined Butterflyfish
(Big) Long-Nosed Butterflyfish	Racoon Butterflyfish	Yellow-Dotted Butterflyfish
Copper-Banded Butterflyfish	Dotted Butterflyfish	Black-Backed Butterflyfish
Orange-Banded Butterflyfish	Ovalspot/Mirror Butterflyfish	Spot-Tail Butterflyfish
Humphead Bannerfish	Bennett's/Eclipse Butterflyfish	Panda Butterflyfish
Asian Butterflyfish	Bluespot Butterflyfish	Eight-Banded Butterflyfish
Burgess' Butterflyfish	Highfin Coralfish	Reticulated Butterflyfish
Ornate Butterflyfish	Two-Eyed Coralfish	Saddled Butterflyfish
Meyer's Butterflyfish	Brown Banded Butterflyfish	Spotted Butterflyfish
Speckled Butterflyfish	Ocellate Coralfish	Yellowtail Butterflyfish
Pacific Double-Saddle Butterflyfish		

Appendix B: Target Fish Family Abundance

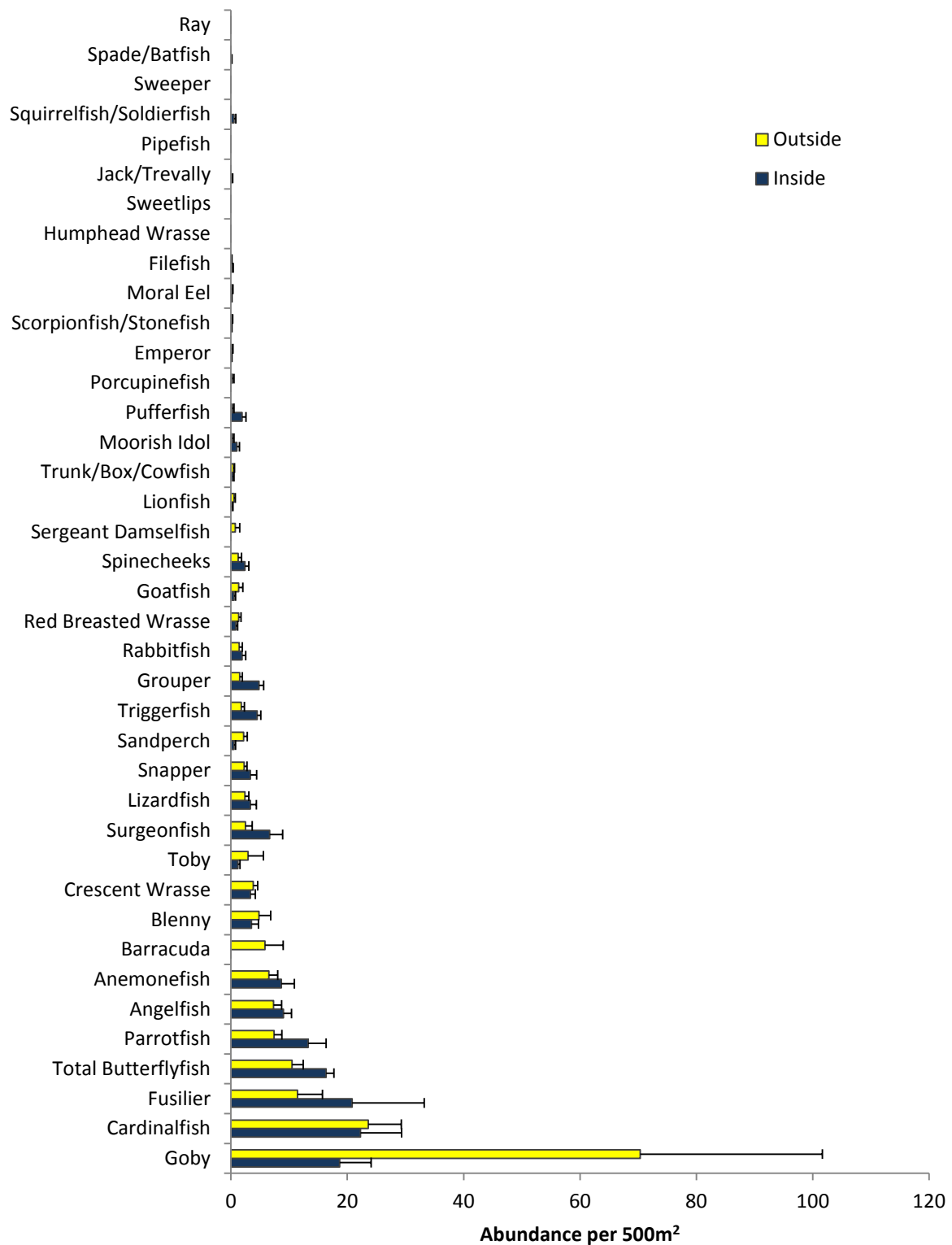


Figure 24 - Average abundance of target fish families. Data are mean average per replicate, error bars indicate Standard error of the Mean

Appendix C: Target Invertebrate Abundance

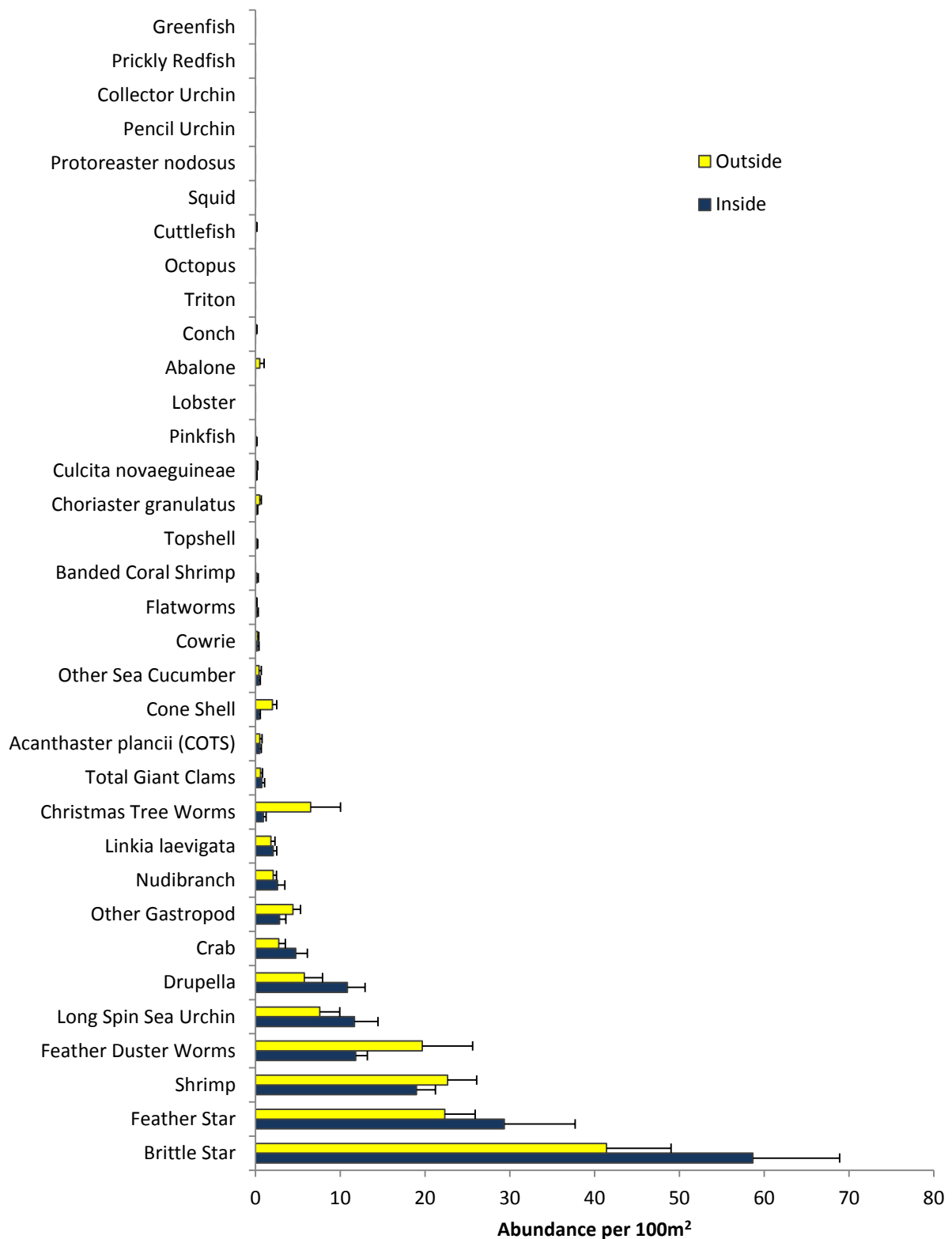


Figure 25 - Average abundance of target invertebrate species and families. Data are mean average per replicate, error bars indicate Standard Error of the Mean.

Appendix D: Target Substrates Abundance

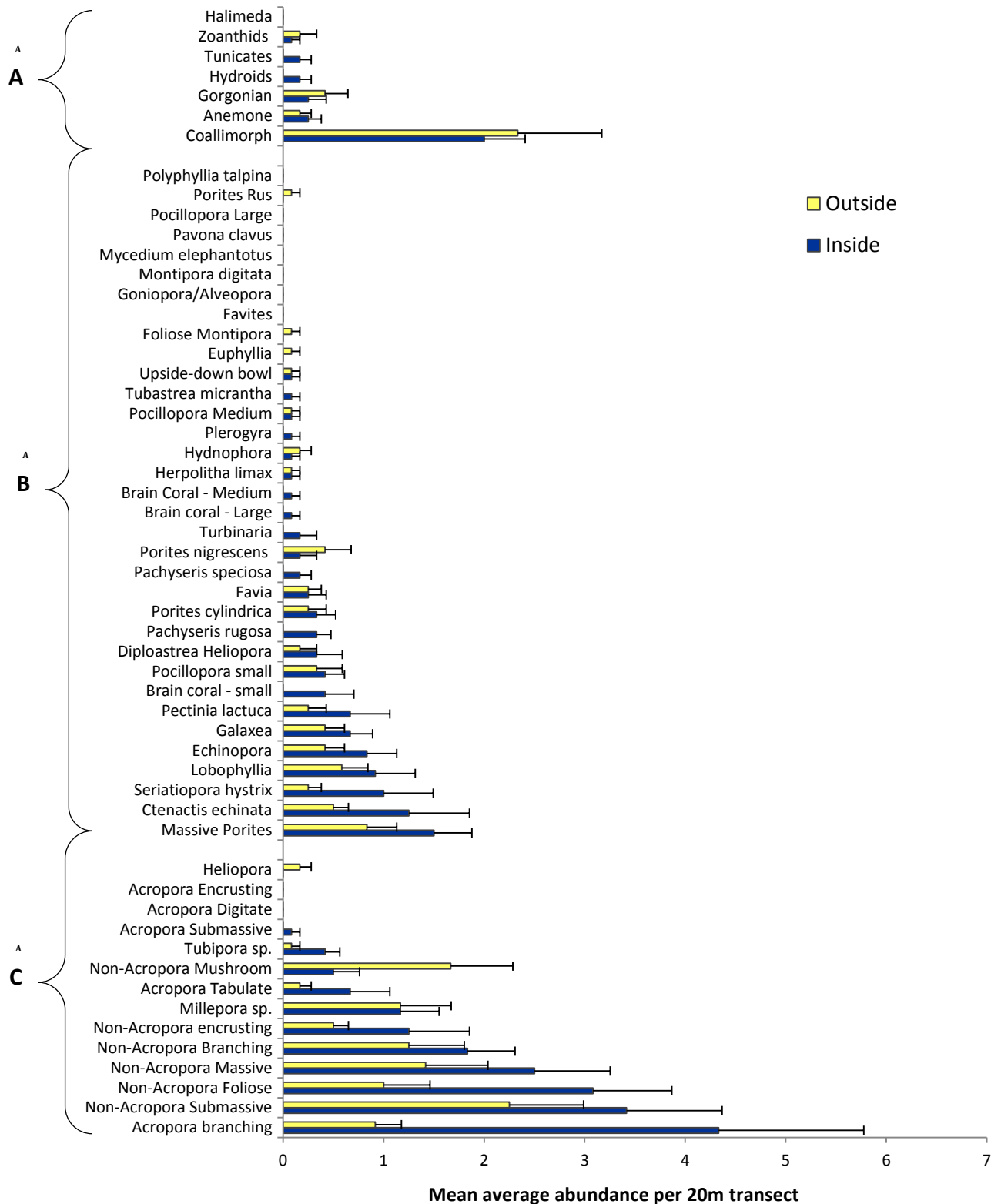


Figure 26 - Average abundance of benthic organisms classed under substrate category "Other" (A), target coral species and families (B), and hard coral life form categories (C). Data are mean average per replicate, error bars indicate Standard Error of the Mean.)